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CATERPILLAR VERSUS DINOSAUR?

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A PAPER BY S. E. FLANDERS in the first issue of *The Journal of Research on the Lepidoptera* (Flanders, 1962) bears the intriguing title, "Did the caterpillar exterminate the giant reptile?" In his discussion, the "abrupt end of the Age of Reptiles during the Cretaceous period is ascribed to a newly emerged order of insects, the Lepidoptera, on the supposition that for a brief period it regulated the world's supply of plant life at starvation levels for the dependent reptiles." The argument for this hypothesis rests in part on modern examples of large-scale devastation of certain species of plants by the larvae of Lepidoptera, and in part on assumptions concerning the time of origin and expansion of this order, the nature of plant life during the Cretaceous period, and the habits and relationships of the "giant reptile."

Many explanations have been proposed for the extinction of dinosaurs and several other groups of reptiles at the end of the Cretaceous, but there is not yet any general agreement as to the most important causes. The proposals are conjectures, having little or no direct evidence to support them. The theory under discussion adds another to the list. The consensus among paleontologists now is that one or two "causes" are not sufficient, and that the extinction of these animals is a more complicated phenomenon than it has seemed. While it is possible that destruction of food-plants by caterpillars has at times contributed to extinction of some herbivorous reptiles, and thus indirectly to that of their predators, the present writer thinks that a close look at what happened in the Mesozoic might be helpful in judging this hypothesis.

Our knowledge of fossil Lepidoptera is scanty, but the earliest known moth appears to be *Eoses triassica,* described from Upper Triassic beds in Queensland (Tindale, 1945). It is known only from a fore and hind wing, of which the venation agrees broadly with that of Jugatae (Homoneura); Tindale placed it in a new, more primitive suborder, Eoneura. Thus the order must have originated more than a hundred million years before the extinction of dinosaurs, although leaf-eating caterpillars might not have characterized the earliest genera and families of moths. Reports of moths and butterflies from the Jurassic lithographic limestone in Bavaria are based on specimens now attributed

to other orders, especially Homoptera. Unless more information appears in Frank M. Carpenter's forthcoming volume on fossil insects in the "Treatise on Invertebrate Paleontology," we can say nothing specific about Lepidoptera of the Jurassic and Cretaceous; none are mentioned in the "Traité de Paleontologie," vol. III (1953). In the Cenozoic, however, moths and butterflies of modern families are known, apparently from the Eocene on.

It is reasonable to suppose that the rise of Lepidoptera coincided with that of flowering plants. These plants are known first from the Jurassic, but at least sixteen modern families are represented in Lower Cretaceous rocks; by the late Cretaceous many existing species of trees had appeared. The length of the Cretaceous was about 70 million years. From its close to the present time was a little less, say 63 million years, according to recent determinations (Kulp, 1961). But we cannot, in the nature of the case, show evidence that caterpillars appeared in great numbers in the late Cretaceous, or that they were then so free of parasites or predators that they could, by worldwide devastation of all sorts of plants, bring starvation upon the reptiles.

Some of the statements of Flanders concerning reptiles bear comment from the viewpoint of a paleontologist. For instance, "The inherent weakness of the reptile was an extraordinary need for an abundance of plant material . . . The small size of today's descendent reptiles, the vegetarian turtle, the predatory crocodile, the snake, and the lizard, is evidence of the giant reptile's elimination by starvation and predation." A sauropod, hadrosaur, ankylosaur or ceratopsian dinosaur may have eaten a large quantity of vegetation, the amount depending on size and activity. These animals were present in the late Cretaceous and occupied a position comparable in some ways to that of the browsing mammals of the Cenozoic. But their extinction does not seem to have been abrupt; it was a slow, uneven decline probably extending through millions of years, and does not differ so far as we know from the decline and disappearance of various other groups of animals at earlier and later times. The flying pterosaurs, whose food was probably fish, declined and died out at about the same time as the dinosaurs. So also did mosasaurs, a specialized line of giant marine fish-eating lizards; so too the very different aquatic plesiosaurs, as well as a few late Cretaceous ichthyosaurs and carnivorous dinosaurs.

No living reptiles are directly descended from any of the above-mentioned Mesozoic reptiles. Turtles and crocodiles originated in the Triassic and have continued with no fundamental changes to the present time. Lizards are known first from the Jurassic, snakes from the Cretaceous, and their size cannot be taken as evidence of any changes among the giant reptiles. These giant reptiles were clearly not a single natural group, nor, on the other hand, were all members of the orders to which they belonged of great size. In the two orders of dinosaurs, for example, there were some species, both early and late, that failed to reach the size of an average alligator.

Efforts to explain the extinction of dinosaurs and various other reptiles in the Cretaceous period ought to take into account a number of possible causes. The one proposed by Flanders does not give the answer to several problems, such as the disappearance of various unrelated and ecologically different groups, not necessarily of large animals, and the survival beyond the Cretaceous of certain other reptiles, not necessarily small. There is no evidence of either a biological or a geological catastrophe of large proportions at the close of the Mesozoic, unless the slow retreat of epicontinental seas in some areas can be so described. Probably the answer will eventually be found in a combination of many factors.

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